

## CONSTELLATION-X SXT

UNIT: OAP2  
DATE: January 15, 2003  
REVISION: 01  
DOCUMENT: D:\cxm\_sxt\_assy\OAP2\_FEA\_Results\_Jan\_15\_2003.doc  
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DESCRIPTION: Thermal Gradient and Bending Moment Results, January 15, 2003

### **Summary**

We have analyzed the effects of thermal gradients on OAP2 performance. The results are summarized in the table below.

Case	HPD(50 Deg Aperture)
1G On edge	0.72
1G flat	4.78
1G Vertical, in-plane support	1.50
1G Vertical, offset support	1.12
Thermal soak, per degree C	0.27

The performance results are acceptable.

### **Thermal Sensitivities**

The thermal sensitivity is much reduced from earlier work. This is due to a series of changes in the configuration, most of which have produced reductions in the thermal sensitivity. Table 1 presents sensitivity data for 14 different configurations in terms of HPD per unit ppm strain. Entries in the table are ranked in order of sensitivity, from most sensitive in row 1 to least sensitive in the bottom row. The top two entries (Cases 1 and 2) are from our December 2001 work. The configuration was glass only with either fixed (all six DOF zero) or pinned (3 translation DOF zero, rotations free) boundary conditions. Five equally spaced supports were placed at each end of the optic. In some cases supports were added in the middle of each edge. These two cases had very high sensitivity and were representative of the thermal sensitivities obtained last year from the glass-only configuration.

The next seven cases in order of sensitivity are all variations of glass-only configurations. Cases 3 and 4 have five supports at each end, but the support locations and optic azimuthal extent are different from

cases 1 and 2. Cases 5 through 9 have six supports at each end and their sensitivity is lower than the five support cases.

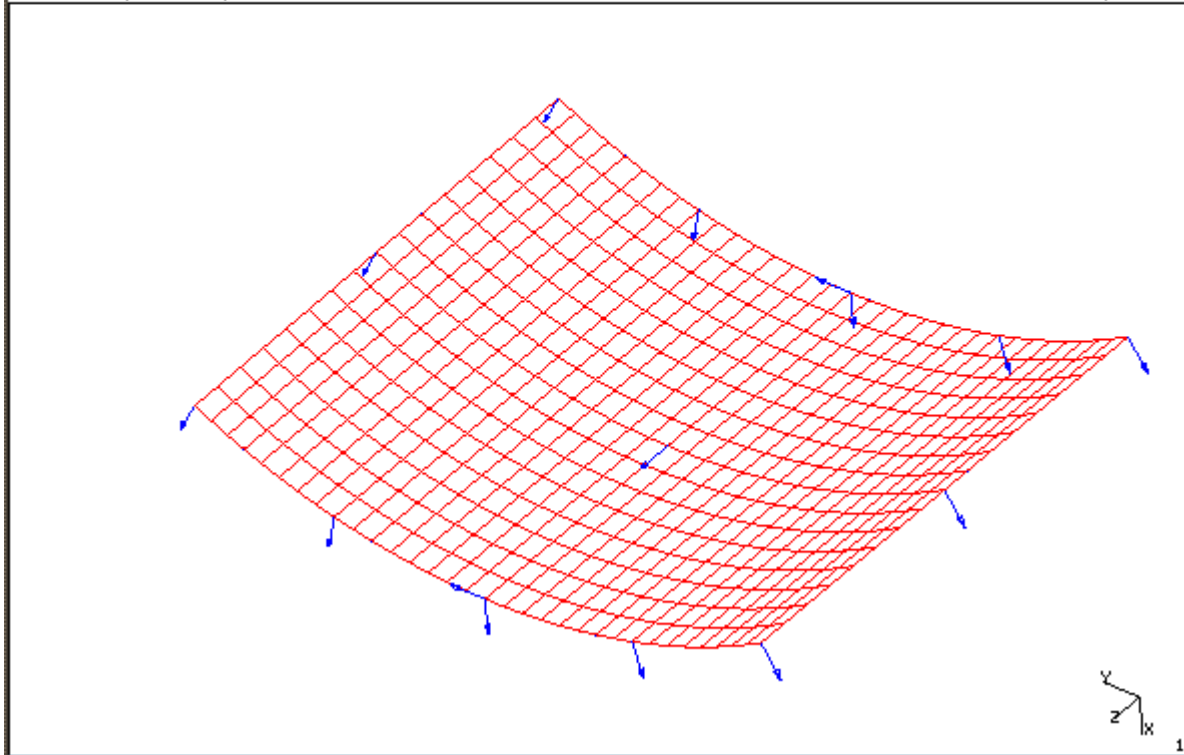
The bottom five cases in terms of sensitivity are all OAP2 model cases with various configurations. In these cases we are modeling the OAP2 housing and support struts, which add flexibility to the system and somewhat relieve the constraint on the glass. We also have six attachment points at each end and possibly one on each edge, depending on configuration. The glass itself is 54 degrees in angular extent. Case 10 has edge struts, which increases sensitivity (by a factor of 2) of the OAP2 vs. configurations without these struts. Since they did not help in the gravity cases they were deleted from the OAP2 baseline design. Cases 11 and 12 were run with the “initial” OAP2 configuration, which had 3/16” walls and flat titanium strips holding the P and H housings together. The absence of an interferometer window (“hole”) in case 11 and its presence in case 12 did not seem to make much difference in performance. Finally, the bottom two cases (lowest in thermal sensitivity) are for the latest GSFC OAP2 design configuration, obtained in early November. “T” sections connect the P and H housings. A flat reference mirror has been added to the P module. There is a wider edge around the hole at aft ends of each module and 3/8” walls are used, except for the radial sides, which are still 3/16”. Beam elements have been added for the on-edge support condition.

## CONSTELLATION-X SXT

Case #	Configuration Name	# Side Supports	# End Supports	Type Support	HPD per ppm	Comments
1	fit_disp_28	0	5	Pinned	4.25	glass only, Dec 2001 even configuration
2	fit_disp_47	1	5	Fixed	3.85	glass only, Dec 2001 even configuration
3	OAP2_fem8_5pts	1	5	Pinned	3.58	glass only, OAP2 Configuration, 5 Points per end
4	p_5pt	0	5	Pinned	3.42	glass only (check case)
5	p_6pt_rotated	0	6	Pinned	2.30	glass only (check case)
6	OAP2_fem8_fixed	1	6	Fixed	2.28	glass only, OAP2 Configuration
7	OAP2_fem8_pinned	1	6	Pinned	2.16	glass only, OAP2 Configuration
8	OAP2_fem8_pinned_even	1	6	Pinned(even spacing)	1.96	glass only, OAP2 Configuration
9	p_6pt	0	6	Pinned(even)	1.88	glass only (check case)
10	OAP2_fem2	1	6	Attached to struts	1.38	OAP2 initial, 3/16 Ti walls, With Hole
11	OAP2_fem3	0	6	Attached to struts	0.59	OAP2 initial, 3/16 Ti walls, no edge-struts, No hole
12	OAP2_fem2a	0	6	Attached to struts	0.58	OAP2 initial, 3/16 Ti walls, no edge-struts, with hole
13	OAP2_fem9	0	6	Attached to struts	0.27	November Baseline, with hole, no edge struts
14	OAP2_fem10	0	6	Attached to struts	0.20	Nov baseline, flexured struts with hole, no edge struts

**Table 1 – Thermal Sensitivity per Unit ppm Strain**

I-DEAS Master Series 7m1 : Simulation 02-Dec-01 10:47:30  
Database: /usr/people/davis/ms7/cx-mm\_0.mf1 Units : MM  
View : No stored View Display : No stored Option  
Task : Boundary Conditions Model/Part Bin: Main  
Model: thk 0.40 mm Parent Part: Part1



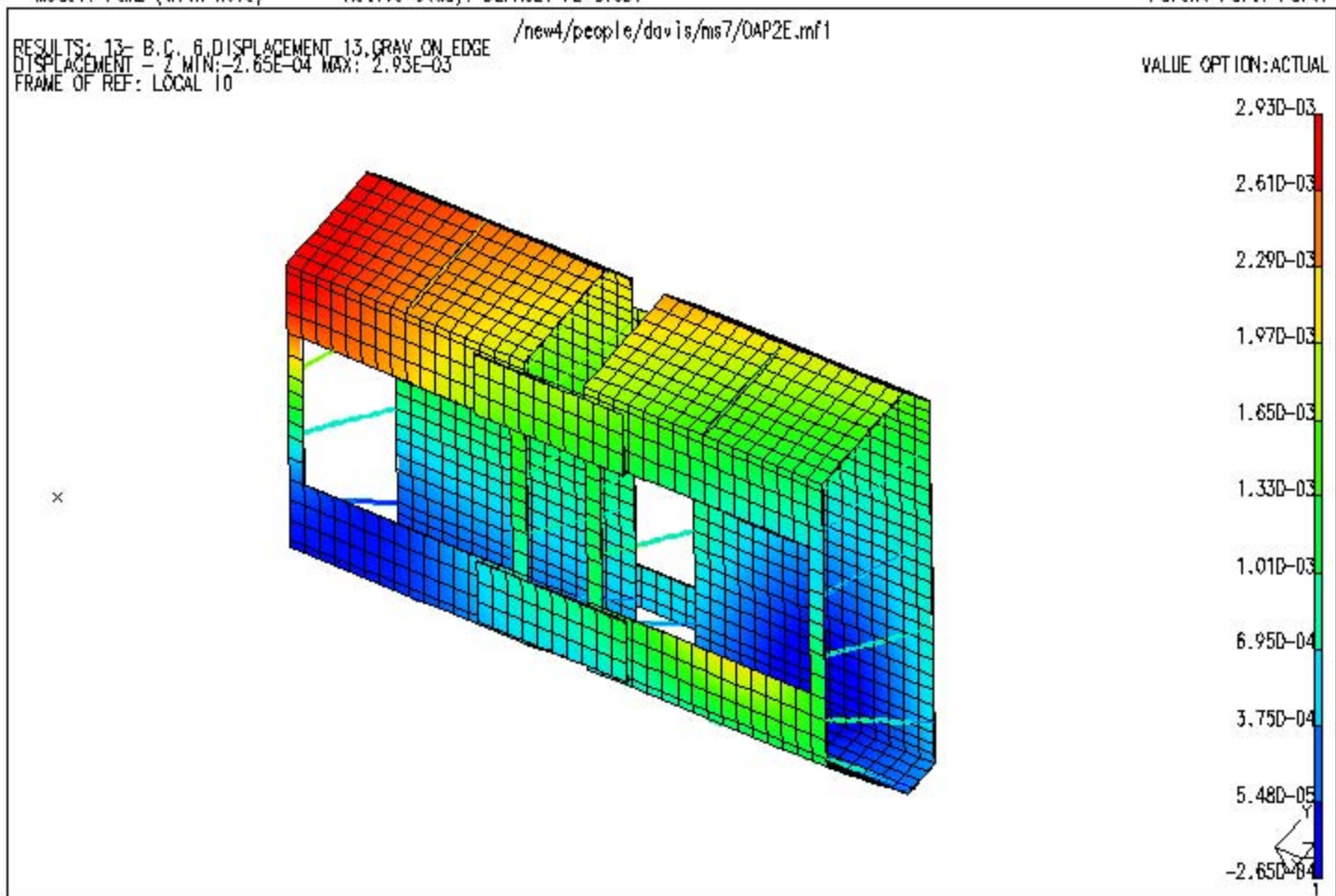
**Figure 1 – Glass-Only FEA Models**



I-DEAS 9 : Central Engineering HT : Users.Davis : /new4/people/davis/ms7/OAP2  
Database: /new4/people/davis/ms7/OAP2E.mf1  
View : No stored Workb\_View  
Task : Post Processing  
Model: Fem2 (with hole) Active Study: DEFAULT FE STUDY

19-Nov-02 08:46:54  
Units : MM  
Display : No stored Option  
Model/Part Bin: Main  
Parent Part: Part1

RESULTS: 13- B.C. 6, DISPLACEMENT 13, GRAV ON EDGE /new4/people/davis/ms7/OAP2E.mf1  
DISPLACEMENT - Z MIN: -2.65E-04 MAX: 2.93E-03  
FRAME OF REF: LOCAL 10

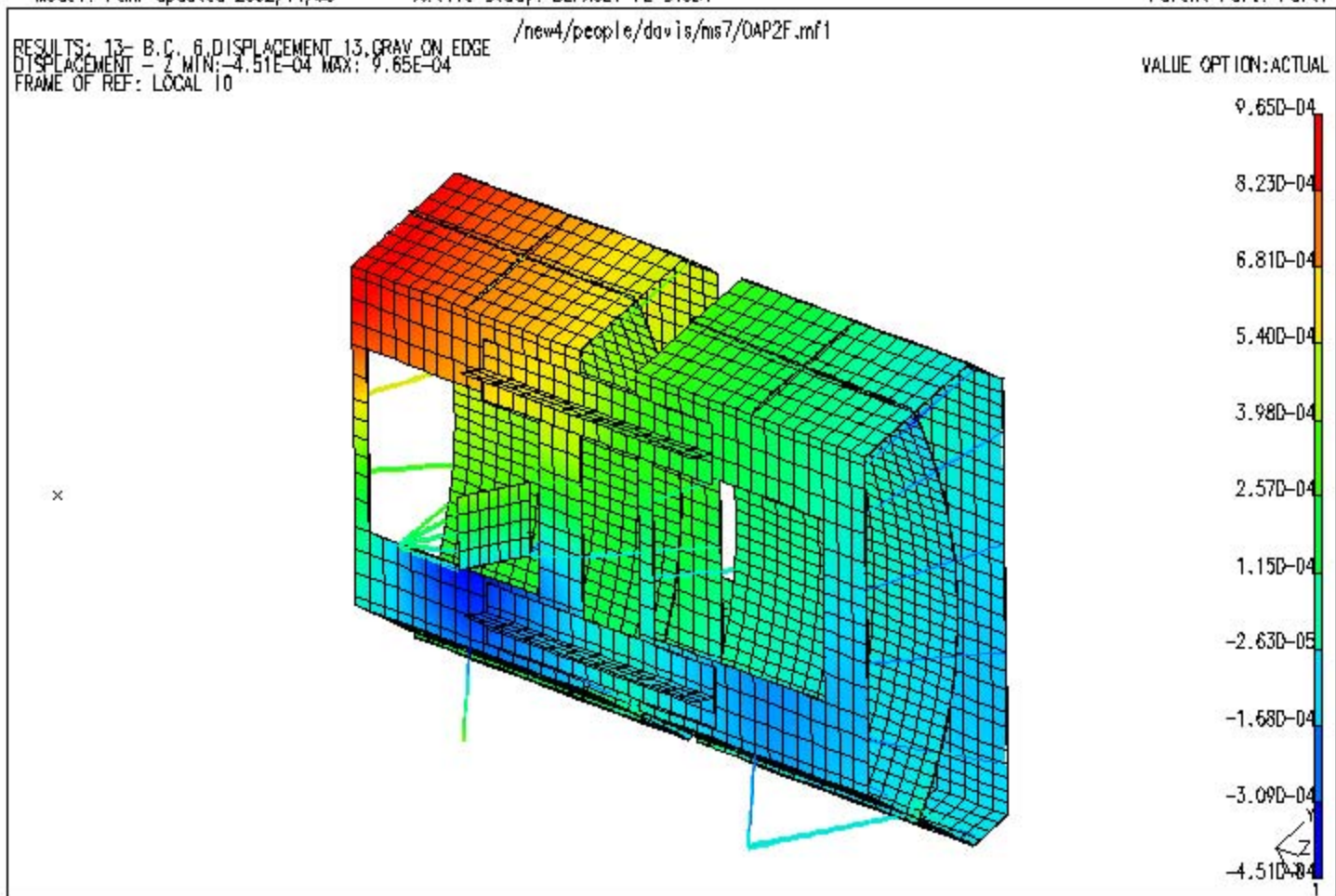




I-DEAS 9 : Central Engineering HT : Users.Davis : /new4/people/davis/ms7/OAP2  
Database: /new4/people/davis/ms7/OAP2F.mf1  
View : No stored Workb\_View  
Task : Post Processing  
Model: Fem updated 2002/11/05 Active Study: DEFAULT FE STUDY

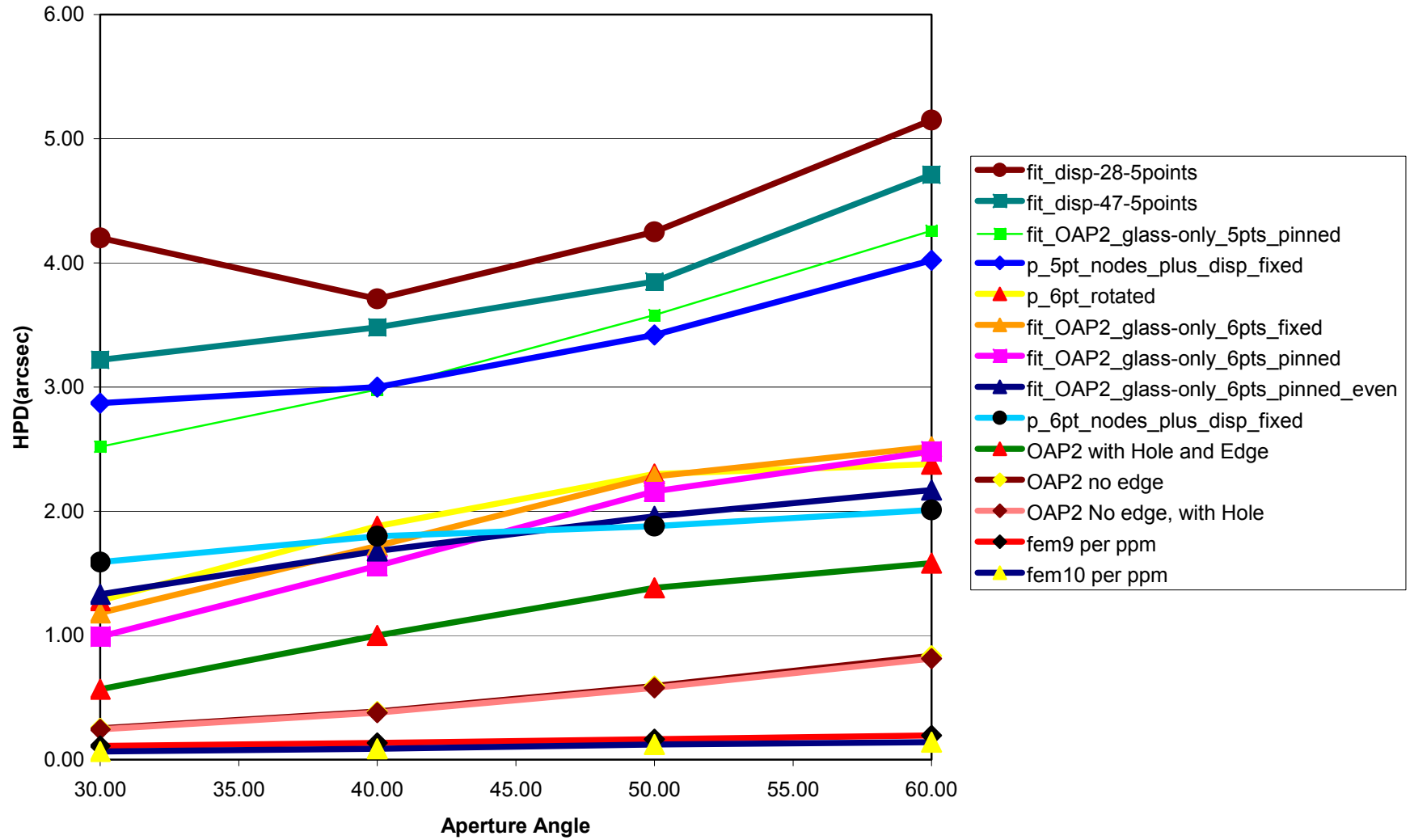
18-Nov-02 16:30:22  
Units : MM  
Display : No stored Option  
Model/Part Bin: Main  
Parent Part: Part1

RESULTS: 13- B.C. 6, DISPLACEMENT 13, GRAV ON EDGE /new4/people/davis/ms7/OAP2F.mf1  
DISPLACEMENT - Z MIN: -4.51E-04 MAX: 9.65E-04  
FRAME OF REF: LOCAL 10





OAP2 Thermal Sensitivity - 1PPM Strain



## CONSTELLATION-X SXT

model file	model	Hole?	Edge Struts?	description	Results file
OAP2E	fem1 (baseline model)	No	Yes	3/16 walls, no hole, flat strips tying P-H together, mid-side struts	fit_OAP2_400
OAP2E	fem2 (with hole)	Yes	Yes	same as fem1 but added 175mm x 92.6mm windows	fit_OAP2_w_hole
OAP2E	fem2a (with hole/no edge struts)	Yes	Yes	same as fem1 but added 175mm x 92.6mm windows	fit_OAP2_fem2a
OAP2E	fem3 (no edge struts)	No	No	same as fem1 but edge struts removed	fit_OAP2_no-edge-struts
OAP2E	fem4 (3/8 thk wall - no hole)	No	Yes	3/8 walls, no hole, flat strips tying P-H together, mid-side struts	fit_OAP2_..._fem4
OAP2E	fem5 very stiff	No	Yes	same as fem4 but Titanium stiffness x 1e6	fit_OAP2_rigid_Ti
OAP2E	fem6 very stiff no edge restr	No	No	same as fem4 but Titanium stiffness x 1e6 and no mid side struts	fit_OAP2_rigid_Ti_...no-edge-struts
OAP2E	fem7 stiff zero cte no edge struts	No	No	same as fem6 but zero cte titanium	fit_OAP2_rigid_Ti_zero-cte
OAP2E	fem8 glass only	N/A	N/A	glass only	fit_OAP2_glass-only
OAP2F	fem9 updated 2002/11/05	Yes	No	modified to latest GSFC model, "T" sections connecting P-H, added flat reference mirror to P module, wider edge around hole at aft ends of each module, 3/8 walls except radial sides, added beam elements for on-edge support condition	fit_fem9
OAP2F	fem10 flexured struts	Yes	No	same as fem9 except for flexured struts at front of P and back of H 0.125" wide x 0.0625" thick	fit_fem10

